TEJAS

The Indian Light Combat Aircraft

Aeronautical Development Agency
Ministry of Defence, Govt. of India

Tejas-Indian Light Combat Aircraft (LCA) together with its variants, is the smallest and lightest Multi-Role Supersonic Fighter Aircraft of its class. This single engine, Compound-Delta-Wing, Tailless Aircraft is designed and developed by ADA with HAL as the principal partner along with DRDO, CSIR, BEL, DGAQA, IAF & IN to meet diverse needs of the Indian Air Force (IAF) and Indian Navy (IN).

Tejas is an amalgamation of contemporary concepts and technologies such as relaxed static-stability, fly-by-wire Flight control, advanced glass cockpit, integrated digital avionics systems and advanced composite materials for the airframe.

LCA-Fighter (Indian Air Force)

LCA Trainer (Indian Air Force)

LCA Navy Fighter (Indian Navy)

LCA Navy Trainer (Indian Navy)

Contents

ADA

The nucleus of Tejas Aircraft is Aeronautical Development Agency (ADA) whose principal partner is Hindustan Aeronautics Limited. Indian Air Force, Indian Navy, DGAQA, BEL, various DRDO and CSIR Laboratories, Private and Public Sector undertakings and several academic institutions have actively participated and contributed to this truly national venture which has directly and indirectly bridged major technological gaps in several disciplines.

Today we have two Technology Demonstrators (TDs), Five Prototype Vehicles (PVs) which includes Two Twin Seater / Trainer, Seven Limited Series Production Vehicles (LSP) and two Naval prototypes undergoing Flight Trials. The LCA Tejas Series Production-1 (SP1) was handed over by Defence Minister to Indian Air Force. Initial block of flight testing of Naval variant of LCA was successfully completed. A significant milestone of the maiden ski jump launch of the first LCA Navy Prototype was successfully carried out at Goa in Dec 2014. The progress of the Tejas is well marked by completion of Initial Operational Clearance (IOC) leading to the delivery of the first Series Production (SP1) aircraft to the IAF. The programme is triumphantly moving towards certification for Final Operational Clearance (FOC).

LCA AF MK1 FIGHTER

PERFORMANCE

• Max speed	Supersonic at all altitudes
• Service Ceiling	50,000 ft
• 'g' Limits	+8/-3.5

DIMENSIONS

• Span	08.20 m
• Length	13.20 m
• Height	04.40 m

WEIGHT

• Take-off Clean	9800 kg
• Empty	6560 kg
• External Stores	3500 kg

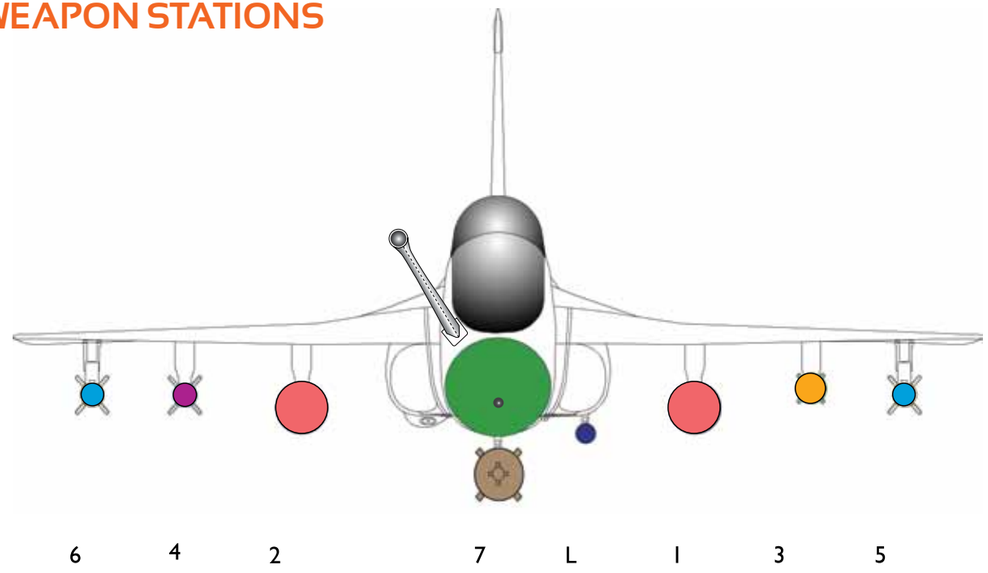
POWER PLANT

F404-GE-IN20

SPECIAL FEATURES

¤ Compound Delta Planform
¤ Relaxed Static Stability
¤ Composite Structure
¤ Fly-by-wire Flight Control
¤ Computer based monitor and control of Electro Mechanical Systems
¤ Glass Cockpit
¤ Multi-Mode Radar

WEAPON STATIONS



	6	4	2	7	L	1	3	5
BVRM		●	●			●	●	
CCM	●							●
DROP Tanks			●	●		●		
SPL Sensors					●			
Bombs		●	●	●		●	●	
LGB		●	●	●		●	●	

EXTERNAL STORES

¤ Air-to-air Missiles
¤ Air-to-ground Missiles
¤ Anti-ship Missiles
¤ Laser Guided Bombs
¤ Conventional Bombs
¤ GSh-23 Gun
¤ Drop Tanks

ACHIEVEMENTS


Release of Bomb from LCA


LCA Under Night Flying Trial


LD Pod Integration on LCA


LCA Under Wet Runway Trials

The first prototype of the light combat aircraft (LCA) Tejas' Naval version - LCA NP1 completed its maiden flight as the part of the carrier compatibility tests at the shore-based test facility in Goa.

Tejas has participated in Hot Weather, Cold Weather, Iron Fist, Weapon Trials comprising of Bomb releases in CCRP/CCIP, R73E missile launching in MMR/HMDS Guided Mode, Stick bombing and separation trials of emergency Jettison of multiple stores/ Drop tank conducted at various locations in India.

- Air superiority missions with R73E CCM guided by MMR/ HMDS successfully demonstrated.
- Operational Air Support Missions with 1200/800 Ltr Drop tank & 1000 lb bombs in CCRP/CCIP modes completed.
- Laser guided missions with Litening POD demonstrated for IOC envelope.
- Multi role capability demonstration during IRON FIST by simultaneous release of Laser guided bomb, Chaff & Flare dispensation and R73E missile within a span of 100 secs.
- Night Flying.
- Wake Penetration.

ACHIEVEMENTS

- Successfully completed more than 2871 flights.
- Sensor evaluation of MMR, Litening POD, HMDS, RWR, TACAN, IFF, VOR-ILS successfully completed.
- Spool down engine relight successfully demonstrated.
- Envelope expansion upto 24° AOA completed.
- Chaff & Flare dispensation integrated with RWR successfully completed.
- Operational Readiness Platform scramble readiness demonstrated.
- Fuel System, Brake Management System and General Systems performance demonstrated.
- Production Equipment Standard of Preparation & Drawing Applicability Lists (SOP/DAL) released.
- The First LCA Navy Prototype has completed its maiden Ski-Jump launch at Goa in Dec 2014


LCA Under Hot weather Trial at The Hottest Part of India (Temperature >48° C)


LCA Under Cold Weather Flight Trials at Leh

LCA AF MK1 TRAINER

- An operational type trainer & two seat aircraft for Tejas AF Mk1; has been developed by ADA and its partners
- Two prototype trainer aircraft (PV5 and PV6 the Aircraft being close to series production trainer); are currently undergoing rigorous flight tests
- Tejas AF Mk1 Trainer Final Operational Clearance (FOC) target is December 2015
- Tejas Trainer will have capabilities close to the fighter

Four plus generation technologies including:

- Open Architecture Avionics with Glass Cockpit
- Quadruple Digital Flight Control System
- Extensive use of Carbon Composites in Aircraft Structure

Flight Envelope

- Speed: 1.6 Mach
- Structural Load Limits: +8g and -3.5g
- AOA: 26°
- Ceiling: 50,000 ft

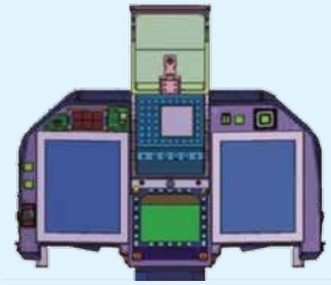
- ✓ All Weather and Day / Night Operations
- ✓ Eight hard stations to carry sensors, external fuel tanks for extended range and various weapons including BVR missiles and Laser guided bombs
- ✓ Tejas Trainer will facilitate smooth graduation of young IAF pilots to Tejas AF Mk1 Fighter
- ✓ It can also play the role of a Generic Military Fighter Trainer

LCA AF MK2

LCA AF Mk2 is an improvement over LCA AF Mk1 with higher thrust engine. This aircraft will have improved survivability, maintainability and obsolescence mitigation. Active Electronically Scanned Array (AESA) Radar, Unified Electronic warfare Suite (UEWS) and On-Board Oxygen Generation System (OBOGS) are some of the state of the art technologies planned to be integrated. The cockpit design has been improved with bigger size, smart Multi function Displays (MFD) and smart Head Up Display (HUD).

KEY FEATURES

- Improved Performance, Survivability & Maintainability
- Higher thrust Engine
- Aerodynamic improvements
- Active Electronically Scanned Array (AESA) Radar
- Digital Flight Control Computer Upgrade
- Unified Electronic Warfare Suite
- Avionics Upgrade
- Glass Cockpit
- Fuel Dumping System
- On Board Oxygen Generation System
- Increased Fuel Capacity
- Increased Pay load
- Obsolescence Management



Improved Cock Pit

DIMENSION

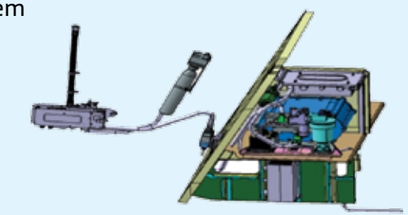
Span : 8.2 m
Length : 13.7 m
Height : 4.4 m

POWERPLANT

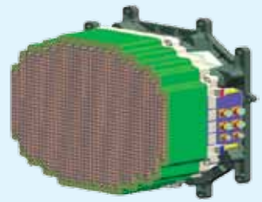
GE-F414-INS6

PERFORMANCE

Service Ceiling : 15 km
'g' Limits : +9 / -3.5
Max speed : Supersonic



On-Board Oxygen Generation System (OBOGS)



Active Electronically Scanned Array (AESA) Radar

LCA NAVY MK1


Take-off Area


Landing area


Optical Landing System

LCA Navy Programme to design and develop a Carrier Borne Fighter Aircraft was sanctioned in 2003 after the successful initial flight testing of LCA (Air Force) variant, Tejas. Two prototypes, a two seat Trainer (NP1) and a single seat Fighter (NP2) with more internal fuel have been developed in Phase-1 of the programme. These two aircraft will be used as Technology Demonstrators to carry out Carrier Suitability Certification and Air Defence Weapon Integration. After initial testing in a typical Air Force 'up & away' flight envelope, Carrier Compatibility Test (CCT) will be carried out in the Shore Based Test Facility (SBTF) built at the Naval Air Station at Goa, replicating an aircraft carrier having Restraining gear and Ski-jump for take-off.

The first LCA Navy prototype, NP1 had its maiden flight on 27 Apr 2012. Since then, it has undergone 3 blocks of flight testing, where it has successfully completed various manoeuvers, flown with centerline drop-tank integrated and has also flown at supersonic speed.

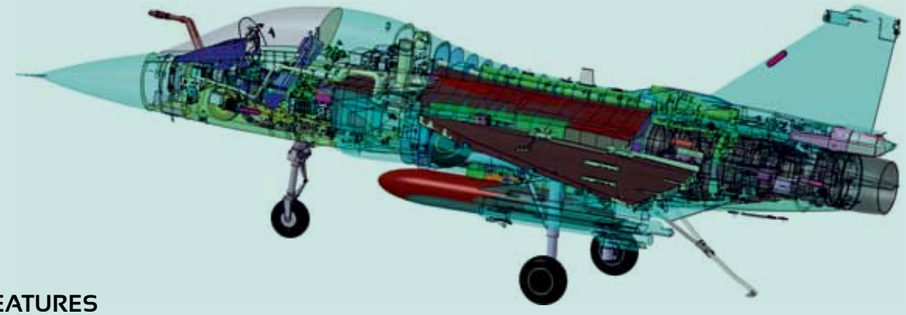
NP1 aircraft has successfully made its maiden Ski-jump Take-off from the Shore Based Test Facility (SBTF) at Goa on 20 Dec 2014. The aircraft is currently undergoing next phase of flight testing.

The second prototype and the first Naval fighter version NP2 has successfully completed its maiden flight in Feb 2015

Once proved ashore, aircraft is cleared for flights on the Carrier for its carrier compatibility

LCA NAVY MK2

Phase-2 of LCA Navy Programme envisages development of two single seat Fighter aircraft with a new higher thrust engine (GE-F414-INS6) and further design optimisation to reduce drag. LCA Navy Mk2 would undergo weight reduction through a redesigned landing gear and associated structure and increased internal fuel as critical driving factors in its design. LCA Navy Mk2 will have enhanced mission performance and better maintainability.



KEY FEATURES

- Single Seat Fighter aircraft with optimised fuselage and wing aerodynamics
- Higher thrust from new engine: GE-F414-INS6
- Redesigned lighter Landing Gear and Arrestor Hook System
- Improved mission performance
- Fuel Dump System
- Designed for up to 4.5g deceleration during arrestment

ROLE

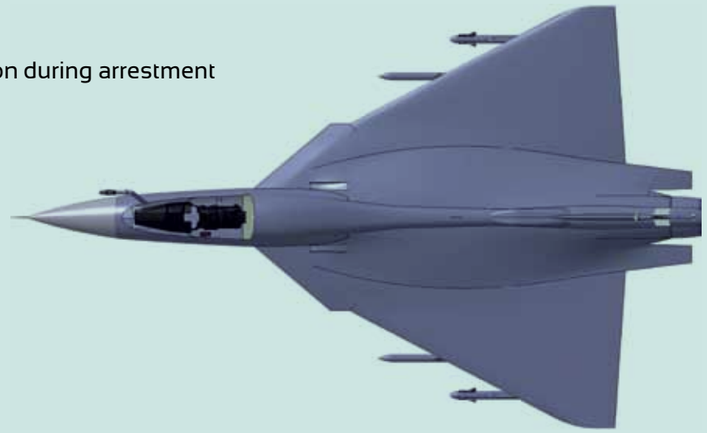
- Air to Air
- Air to Sea
- Air to Ground

DIMENSION

Span : 8.9 m

Length : 14.56 m

Height : 4.64 m



ADVANCED MEDIUM COMBAT AIRCRAFT (STEALTH FIGHTER)

The AMCA is being designed as a stealth, medium weight, twin-engine, fifth generation multi-mission aircraft with the capability to swing roles. The aircraft has trapezoidal wing, all moving horizontal tails and twin canted vertical tails.

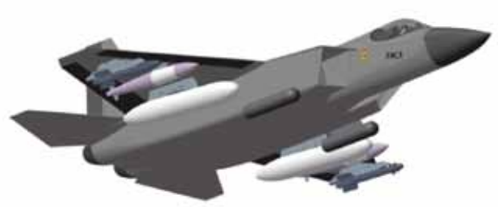
Stealth Configuration

Aiding the Beyond-Visual Range (BVR) combat capabilities of the aircraft are low radar signature, extended detection range and targeting, supersonic persistence and high speed weapon release. The close-combat operations are facilitated by the high angle of attack capability, low infrared signature and all round missile warning system. The stealth mission features the Suppression of Enemy Air Defense (SEAD), precision strike and maritime operations.

Among the advanced technologies that confer stealth capabilities are serpentine air intake, internal weapon bay, Radar Absorbing Structure (RAS), Radar Absorbing Materials (RAM), Frequency Selective Surface (FSS) Radome and Conformal air data probes. The Avionic system features Integrated Modular Architecture (IMA) supporting net-centric warfare capabilities, advanced Pilot Vehicle Interface (PVI), pilot associate and Integrated Vehicle Health Management (IVHM). The integrated flight and propulsion control system will combine the traditional flight control functions with thrust vectoring and engine control functions.

Broad Features:

- Stealth
- Super cruise
- Supermaneuvarability
- Internal Weapon Bay
- Smart weapons
- Active Electronically scanned Array (AESA) Rad
- Advanced Sensors with Data Fusion
- Enhanced reliability and maintainability.



Non-Stealth Configuration

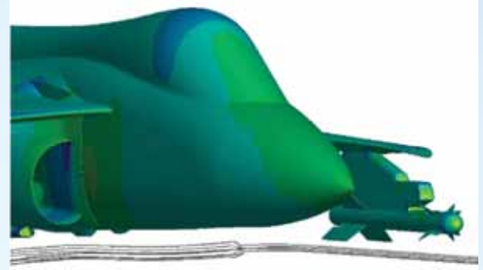
AERODYNAMICS & PERFORMANCE

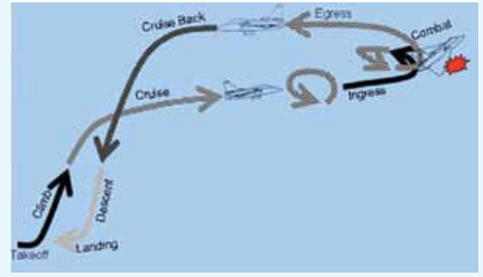
Tejas is an aerodynamically unstable tailless compound delta-wing configuration, optimized primarily for maneuverability and agility. Designed to meet the tactical requirements of a modern air force, Tejas is a multi-role aircraft capable of comprehensive air superiority and air defense roles. The aerodynamic design is a culmination of an intense design process involving extensive Computational Fluid Dynamics and Wind Tunnel studies. Specific aerodynamic features provide excellent aircraft performance in a wider flight envelope:

- Highly optimized wing, with appropriate variation of thickness, camber and twist along the span.
- Cross-sectional area distribution along the length, adjusted for good high speed characteristics
- Leading Edge slats, scheduled for favorable aerodynamic behavior
- Wing-shielded bifurcated air intake duct, with diverters, suitably matched with engine to avoid buzz and to minimize distortion throughout the flight envelope

As a part of the aerodynamic design process, various wind tunnel models have been designed and fabricated for testing a wide range of aerodynamic aspects. Computational methods have been extensively used for fuselage shape optimization, wing design, aerodynamic loads estimation in entire flight envelope, optimization of leading edge devices, performance evaluation of air intakes, configuration refinements, external stores release studies etc. The design and analysis capabilities have grown exponentially and are being refined continuously to meet future operational requirements.

An impressive flight test record of more than 2850 flawless flights, amounting to nearly 2000 flying hours, is a testimony to proven design of best in class tactical fighter. Tejas flight testing is characterized by meticulous planning of test points, aerodynamic data validation and update through system identification techniques, evaluation of aircraft performance and update of performance model leading to a reliable aircraft operating data manual.

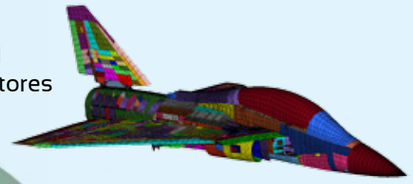




AIRFRAME

MAJOR DESIGN FEATURES

- Optimized Structural Design considering strength, buckling and aero-servo-elastic requirements for carriage of heavy external stores
- Design for manufacturing and assembly (DFMA)
- 90% of wetted surface area is made of Composites.
- Co-cured composite Fin, Co-cured and co-bonded trouser duct and engine bay door made of high temperature composites.
- Indigenously developed metallic materials and processes like large size aluminium alloy forgings, control stretched extrusions, maraging steel and PH stainless steel



MLG Leg

Engine Bay Door

Wheel Lever

Trouser Duct

Drop Tank Emergency Jettison

Arrestor Barrier Net Engagement Simulation

Main Airframe Static Test Rig

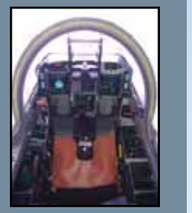
TESTING

- Ground vibration testing of stores configuration
- Successful integration and flight trials of IOC stores
- Integration of Health and Usage Monitoring System

AVIONICS AND WEAPON SYSTEM

OAC MISSION & DISPLAY SYSTEM TEST FACILITY

AVIONICS INTEGRATION TEST FACILITY



GLASS COCKPIT

- Advanced Glass Cockpit with High Performance Graphics to Support Situational Awareness, Decision Support and Data Fusion
- Dual Redundant Open Architecture Mission and Display Computer
- UML Based Modeling, IEEE-12207, ADA-95 On-Board Flight Certified Avionics Application Software
- Computer Controlled Utility System and Management System (USMS)

WEAPON INTEGRATION TEST FACILITITY

MULTI MODE RADAR TEST FACILITY

- Helmet Mounted Sight, Multi Mode Radar, Litening Pod and Radar Warning Receiver
- Digital Weapon Management System Compatible to Russian, Western and MIL-1760C Weapons
- Single Avionics Application Cater to Multiple Variants of Aircrafts
- Well Proven Air-to-Air, Air-to-Ground Attack Modes

GENERAL SYSTEMS

Major Mechanical System includes Microprocessor Controlled Brake Management System, Environment Control System, Fuel System, Nose Wheel Steering System, Landing Gear System, Hydraulic System, Secondary Power System, Life Support System, Escape System.

Major LRUs Developed by ADA are Aircraft Mounted Accessories Gear Box, Filters, Up Locks, QDCs, NRV's, Depressurisation Cock, Gimble joints, Ten different types of Heat Exchangers. All LRUs have been productionised to facilitate Equipping of Series Production.

Aircraft Mounted Accessories Gear Box (AMAGB)

AMAGB is a single input, multi output gear box, which receives its input drive from the engine through Power Take-Off and drives four aircraft accessories on its output pads viz., two hydraulic pumps, one generator and one starter unit. AMAGB is designed and developed by CVRDE, Chennai and production center is HAL - Engine Divsion, Bangalore.

Up Lock

To lock the undercarriage (U/C) and its doors on retraction in the up position. Locking is mechanical and unlocking is controlled hydraulically. M/s Turbo Tech India Pvt Ltd., Bangalore is the Production Center.

Carbon-Carbon Composites for Aircraft Brakes

- Provide drag
- Absorb Kinetic Energy by converting into heat
- Hold Aircraft stationary against Engine thrust
- Carbon-Carbon Brakes are Developed by ASL, Hyderabad and Production Center Graphite India Ltd, Bangalore

Hydraulic Filters

Hydraulic Filters: Hydraulic system is fitted with 9 filters of 6 types to control the particulate contamination in the system. Filter element is developed by M/s Mikro Flo Filters, Hyderbad. Production Center is M/s CTTC, Bhuvaneshwar.

The high performance hydraulic filters are qualified to meet requirements of MIL-F-8815D.

Gimbal Assembly with Venturi

Gimbal Assy. with venturi is designed for Max. Operating Temp: 650 C with Max. Operating Pressure: 37bar'g' and Movement: 10mm (Three axes). M/s Metallic Bellows, Chennai and M/s Veekay Industries, Mumbai are the Production Centers.

Heat Exchangers

Successfully designed, developed by BHEL-HPVP (Formerly BHPV) and flight qualified 10 types of compact plate-fin heat exchangers for LCA-TEJAS aircraft.

Mechanical System LRUs

ADA has Designed, Developed & Flight Qualified Mechanical System Line Replaceable Units (LRUs) for Hydraulic, Fuel, Environmental Control, Secondary Power Systems and other aggregates of Light Combat Aircraft (LCA). M/s GTTC, Bangalore and M/s CTTC, Bhuvaneshwar are the Production Centers.

These units have been qualified for aerospace applications as per MIL standards.

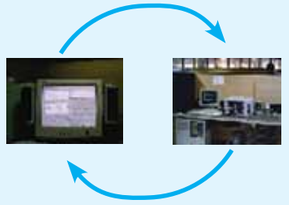
INDEPENDENT VERIFICATION AND VALIDATION

The Independent Verification & Validation (IV&V) laboratory at ADA has been set up to address the safety issues of software intensive systems of LCA Tejas, thereby obtaining a high level of confidence in the operations of new systems prior to their use.

IV&V plays a major role in the design and development of embedded software and ensures the development of hazard free and mission-success oriented software employing modern CASE tools viz. Modelling and simulation, Rapid prototyping, Tool based analysis and Randomised Non Real Time testing (NRT).

Seven safety critical and twenty three mission critical software systems of Tejas have been evaluated and over 2800 successful sorties of Tejas have been completed adhering to IV&V practices.

The IV&V process supports standards like IEEE-12207 and RTCA DO-178B. The IV&V process has evolved to support concurrent software development techniques using OOAD and Model Driven Development (MDD) methods for LCA applications. ADA-IV&V group has also evolved the safe subset of Ada, C and VHDL languages to be used in LCA subsystems and is now in the process of evolving the guidelines for design, development, verification and certification of FPGA to be used in LCA-MK2 and future projects of ADA.



Non Real Time Test Setup

Matlab/Simulink, Rhapsody, Rational Development Suite, AdaTest, Logiscope, LDRA, Understand for Ada/C++, Beyond Compare, Questa Prime and Clearcase are some of the tools used by IV&V during various stages of development to improve the product and make it robust apart from shortening the development and certification time.

Independent Verification and Validation Test Facilities

INTEGRATED FLIGHT CONTROL SYSTEM

- State-of-the-art Full Authority Quadruplex Digital Fly-By-wire Flight Control System
- Fault Tolerant Digital Flight Control Computer with built-in Redundancy Management
- Fail Operational, Fail Operational, Fail Safe DFCS and Fail Operational, Fail Safe Air Data System
- Robust Control Laws for Stability and Command Augmentation, Carefree Manoeuvring, Autopilot Control and Ski Jump Functionalities
- Advanced Flight Control Actuators incorporating both Hydraulic and Electrical Redundancy
- Range of Ground Based Test Facilities for Integrated Flight Control System Development, Handling Qualities Evaluation, Non-Real Time Tests, Real Time Simulation, Hardware-in-loop Simulation, Structural Coupling Tests, Lightning Test, Ground Check out Systems and Flight Test
- Test Facilities equipped with State-of-the-art Flight Dynamic Simulator, Engineering Test Station, Air Data Test Station, High End Projection Systems, Data Acquisition, Analysis and Storage System

IRON BIRD

ENGINEERING IN LOOP SIMULATION

REAL TIME SIMULATOR

LIGHTNING TEST FACILITY

MINI BIRD FACILITY

SYSTEM ANALYSIS & EVALUATION FACILITY

PROPULSION SYSTEMS

- Propulsion System consists of
  - Engine GE-F404-IN20 for LCA Mk1, GE-F414-INS6 for LCA Mk2
  - Jet Fuel Starter (JFS)
  - Engine Health Monitoring Electronic Unit
  - Engine Parts Life Tracking and Management System (Net enabled Ground Stations)
  - Engine maintenance shop and Engine Test Facilities
- Completion of Propulsion Systems flight test points for Full Operational Clearance (FOC)
  - Demonstration of high angle of attack capability, and altitude up to 15 km.
  - Demonstration of in-flight relight capability
  - Demonstration of operation from high altitude, cold weather conditions at Leh, Ladakh.
- Impeccable maintenance record of Engine and Jet Fuel Starter
- Engine Integration activities of GE-F414-INS6 in LCA Mk2 on schedule
- Portable Engine Maintenance Test Facility under development

PROTOTYPE VEHICLES AND PRODUCTION

Proto-Vehicles Build and Up-gradation

- Proto aircraft build leading to first flight
- Upgradation and major improvements towards IOC/FOC
- Integration and flight test of indigenous Actuators, UEWS, OBOGS etc

CAD/CAM & Productionisation

- Development of New Manufacturing Technologies
- HSM, CNC Bending, Friction Stir Welding, Additive Manufacturing
- Tooling for Intermediate Stage wise assembly jigs, ICY Panels
- Implementation of DFMA, GD&T-Stack Up Analysis
- Laser Technologies for Jig Calibration and Reverse Engineering
- NMG Creation & Generation of 3D Electrical Looms

Product LifeCycle Management (PLM)

- Capture and Management of Product & Process Data across Lifecycle
- Advanced CAx authoring Tools for capturing domain data in 3D model
- Digital validation & Optimization of Manufacturing process
- Interfaces with ERP, VR, CAMMS & Connectivity to workcentres
- Decision Support Dashboards Depicting Progress of Various Programs

All Weather Clearance

- Establishment of test facility leading to Aircraft Certification
- Lightning test facility - direct and indirect effects
- Test Rig for Water Tightness
- Wet Run-way for brake performance studies

Ground Handling Equipment

- Indigenous development
- Shorter flight readiness time with multiple operations from single trolley
- Design and development of Loading Trolleys for Squadrons:
- Drop Tanks, Weapons, DFCC, Battery, JFS, Landing Gears etc.

Digital Mock Up

- Digital mock up replaces physical mock up
- Invaluable tool for design data validation and visualization
- Streamlines assembly, equipping and cuts down overall time
- First time built within the country for such complex product

Automatic Cable Harness Tester

- Configured and Commissioned
- Megger, Continuity & Functional checks with Automated Reports
- Significant reduction in Aircraft integration time

QUALITY ASSURANCE AND SYSTEM EFFECTIVENESS

Quality Assurance and System Effectiveness plays a vital role in product assurance ensuring Airworthiness and safety of aircraft

- Reliability and Maintainability
- Survivability
- System Safety and Air Worthiness
- Quality Engineering

Reliability & Maintainability

Product Assurance

Quality Engineering

Survivability

System Safety & Air Worthiness

FLIGHT TESTING

National Flight Test Center is the directorate of ADA dealing with flight testing of LCA. All the flight test and aircraft instrumentation related activities are planned, coordinated and executed by NFTC which is headed by a Test Pilot from Indian Air Force. NFTC has Indian Air Force and Indian Navy test pilots and flight test engineers along with the scientists and engineers for instrumentation who are professionally carrying out the flight testing of the LCA.

National Flight Test Centre

R73 E Missile Firing

Rear View from LCA Cockpit

Flight Test at Leh
(Height = 3230.88 m / 10,600 ft Temperature = -28°C /- 18.4 °F)

Participation in Iron Fist - 2013

AIRCRAFT SYSTEMS MAINTENANCE SIMULATOR

MAINTENANCE SUPPORT DEVICE

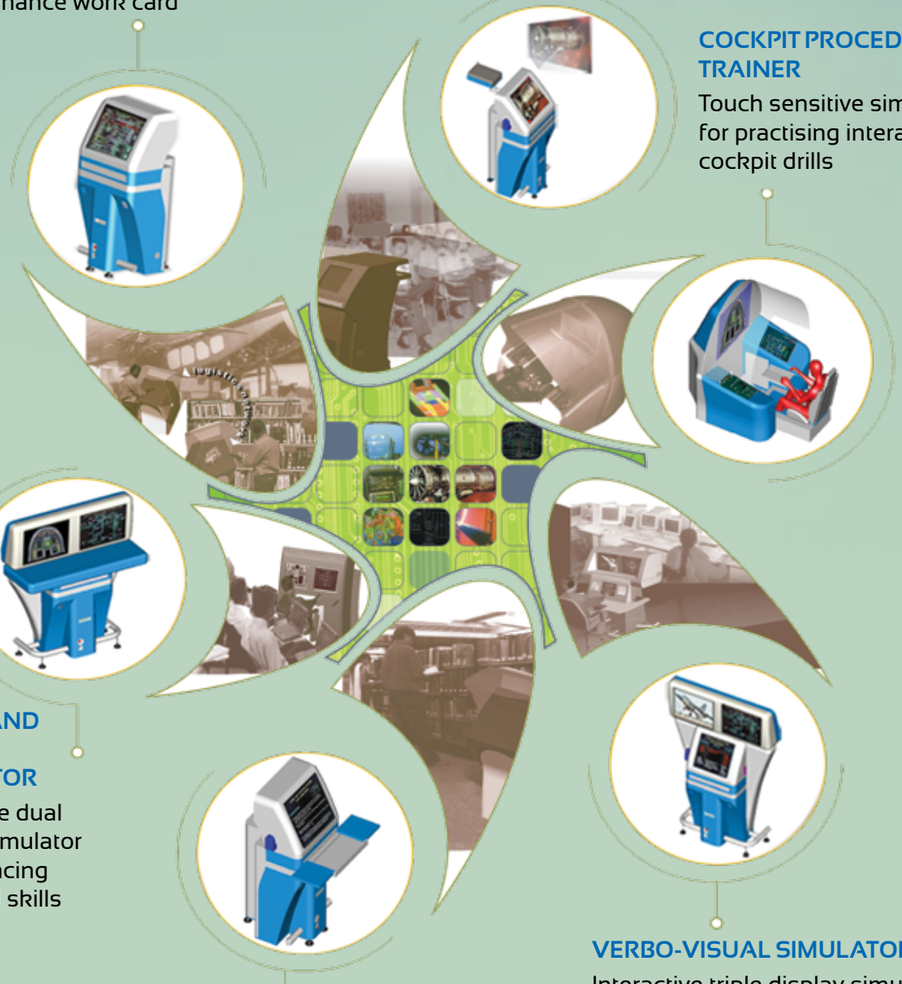
Interactive parts browser to support logistics function and electronic browser to refer maintenance work card

TUTORING SIMULATOR

Dual display simulator providing dynamic projection to trainees and tutoring assistance to instructor

COCKPIT PROCEDURE TRAINER

Touch sensitive simulator for practising interactive cockpit drills



CAUSE AND EFFECT SIMULATOR

Interactive dual display simulator for enhancing analytical skills

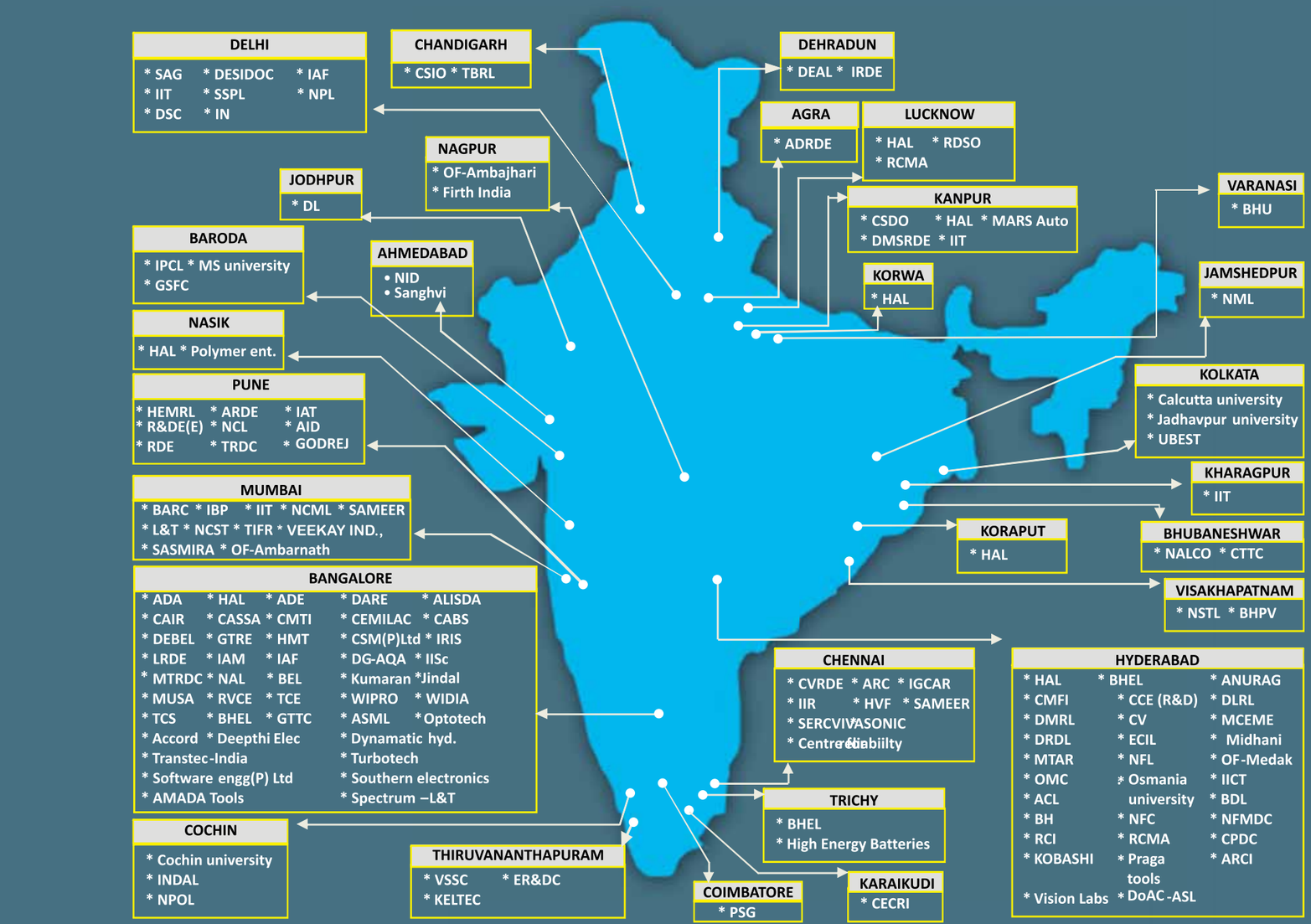
I-MANUAL BROWSER

Touch sensitive electronic manual with hyperlink and dynamic simulation features

VERBO-VISUAL SIMULATOR

Interactive triple display simulator for procedure training and self study during Own Time Work

WORK CENTRES OF LCA PROGRAMME



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